

PROSPECTS FOR DATING THE SOUTH POLE-AITKEN BASIN THROUGH IMPACT-MELT ROCK SAMPLES. B. A. Cohen¹, R. F. Coker¹, and N. E. Petro². ¹NASA Marshall Space Flight Center, Huntsville, AL, USA (Barbara.a.cohen@nasa.gov); ²NASA Goddard Space Flight Center, Greenbelt, MD, USA.

Introduction: Much of the present debate about the ages of the nearside basins arises because of the difficulty in understanding the relationship of recovered samples to their parent basin. The Apollo breccias are from basin ejecta formations, which are ballistically-emplaced distal deposits that have mixed provenances. The Nectaris, Imbrium, and Serenitatis basins all have mare-basalt fill obscuring their original melt sheets, so geochemical ties are indirect.

Though the geological processes acting to vertically and laterally mix materials into regolith are the same as at the Apollo sites, the SPA interior is a fundamentally different geologic setting than the Apollo sites. The South Pole-Aitken basin was likely filled by a large impact melt sheet, possibly differentiated into cumulate horizons [1, 2]. It is on this distinctive melt sheet that the regolith has formed, somewhat diluting but not erasing the prominent geochemical signature seen from orbital assets [3].

By analogy to the Apollo 16 site, a zeroth-order expectation is that bulk samples taken from regolith within SPA will contain abundant samples gardened from the SPA melt sheet. However, questions persist as to whether the SPA melt sheet has been so extensively contaminated with foreign ejecta that a simple robotic scoop sample of such regolith would be unlikely to yield the age of the basin.

Modeling SPA regolith: We focused on four candidate landing sites within the SPA basin for more detailed modeling (Table 1). Modeling shows that the majority of sites within SPA have only a modest contribution to the regolith from foreign material [7]. Only two basins, Imbrium and Orientale, contribute a majority of the accumulated ejecta. We then added to the global basin dataset 90 craters contained within the boundaries of SPA [4-6]. These craters formed in the SPA terrain, so although their ejecta is “foreign” to each landing site, it is likely geochemically and petrologically within the SPA sample family. Including these craters increases the amount of “foreign” material at each site, but a competing effect is that as smaller craters churn the regolith, material that is directly derived from the SPA impact melt is reintroduced from depth [7, 8].

Impact-melt ages: Any given scoop sample retrieved from regolith that contains the SPA geochemical signature will contain fragments of SPA impact melt as well impact melt from large, distant basins and successive nearby craters, many of which

may have impact-melt compositions similar to (indeed, derived from) the SPA melt sheet.

We assigned each crater and basin a reference age in order to compute statistics of sample abundance. We used this knowledge of impact-melt parentage to construct a simple, Monte-Carlo-like statistical model to understand how many randomly-selected impact-melt fragments would need to be dated, and with what accuracy, to confidently reproduce the impact history of a site.

Conclusions: Even if samples cannot be definitively recognized as SPA melt by other means, our modeling shows that dating of a few hundred impact-melt fragments will yield the age of the SPA basin from such a sample, as well as the ages of nearby craters and basins. The range of ages, intermediate spikes in the age distribution, and the oldest ages are all part of the definition of the absolute age and impact history recorded within the SPA basin region of the Moon.

References: [1] Vaughan, *et al.* (2014) *Planetary and Space Science* 91, 101–106. [2] Hurwitz, *et al.* (2014) *Journal of Geophysical Research: Planets* 119, 1110–1133, doi:10.1002/2013JE004530. [3] Jolliff, *et al.* (2000) *J Geophys Res* 105, 4197–4216. [4] Kadish, *et al.* (2011) *Lunar Planet Sci Conf* 42, #1006. [5] Head, *et al.* (2010) *Science* 329, 1504–7, doi:10.1126/science.1195050. [6] Garrick-Bethell, *et al.* (2009) *Icarus* 204, 399–408. [7] Petro, *et al.* (2016), this conference. [8] Moriarty, *et al.* (2015) *Geophys Res Lett* 42, 7907–7915, doi:10.1002/2015GL065718.

Table 1: Sites in SPA used for this study.

Site	Lat (N)	Lon (E)
Bhabha	-57	198
Bose NW	-51	186
Leibnitz-Oppenheimer	-33	183
Oresme Th	-49	163